APPENDIX I : GIS Training Course Outlines

Introductory Course

- Introduction to GIS
- Raster Data Structures
- Analysis in GIS
- Database Query
- Map Algebra
- Distance / Context Operators
- Vector Data Structures
- Vector Analysis
- Introduction to Remote Sensing
  - Image Exploration
- Digital Image Processing I : Image Restoration
  - Destriping
  - Rubber Sheet Resampling
- Digital Image Processing II : Image Enhancement
  - Contrast Stretch / Compositing
- Digital Image Processing III : Image Classification
  - Unsupervised
  - Supervised
- Digital Image Processing IV : Image Transformation
  - Principal Components Analysis
  - Vegetation Index Mapping
  - Image Ratioing
- Introduction to Global Positioning Systems
- Ground Truth of the Njolomole/Mlangeni Case Study using GPS/GIS
- Completion of Land Cover Mapping of Case Study Area
- Accuracy Assessment
- Data Entry
- Data Transformation
- System Design and Evaluation
- Open forum: GIS and MEMP

Intermediate Course

- **Database Development**
  - **Raster Data Structures**
  - **Raster Data Import**
  - **Raster Interpolation**
  - **Database Import/Export**
- **Change Analysis for Environmental Monitoring**
- **Pairwise Comparisons**
  - **Quantitative Data**
  - **Qualitative Data**
- **Multiple Image Comparisons**
  - **Image Deviation**
  - **Change Vector Analysis**
  - **Image Sequencing**
  - **Temporal Profiling**
- **NDVI Differencing**
- **Landcover Change Analysis**

advanced Course

- **Georeferencing and Geodesy**
- **Uncertainty and Error**
- **Multi-Criteria/Multi-Objective Decision Making**
- **Time Series Analysis**
- **System Design**

List of GOM Officers Receiving GIS Training

Ministry of Research and Environmental Affairs
- **Tawonga Mbale**

Land Resources and Conservation Branch, Ministry of Agriculture
- **Vincent Albert Lameck Mkandawire**
- **Zwide D. Jere**

Meteorological Department
- **M. Gwazantini**
- **J. Nkhokwe**

Forestry Department
- **S. Kainja**
- **J. Luhanga**
- **Patrick S. Jambo**
- **Binie Chongwe**

Water Department
- **Alex Miston Banda**
- **D.V.L. Naketo**
- **P.W.R. Kaluwa**

Surveys Department
- **G.C. Mzembe**
- **E.M. Likombola**
- **Richie B. Muheya**
- **Susan N. Machila**

Fisheries Department
- **Orton M. Kachinjika**
- **Dr. N.C. Mwanyama**

Appendix II : Food Security

From April 1994, almost twenty government officers were trained in GIS and remote sensing techniques. The intensive training process included classroom hands-on instruction, as well as, training in the field. As much as possible, local data sets were adapted for the trainings. Figure 1 is a typical training scene being held at MOREA. Figures 2 and 3 show the illustrate the application developed during the introductory trainings in which the trainees assessed food security issues in Malawi using NOAA AVHRR Satellite Imagery and production data supplied by FEWS Malawi.

Figure 1 : The classroom setting. Classes were held at MOREA in Lilongwe, Malawi using equipment provided by USAID as part of the Malawi Environmental Monitoring Project.

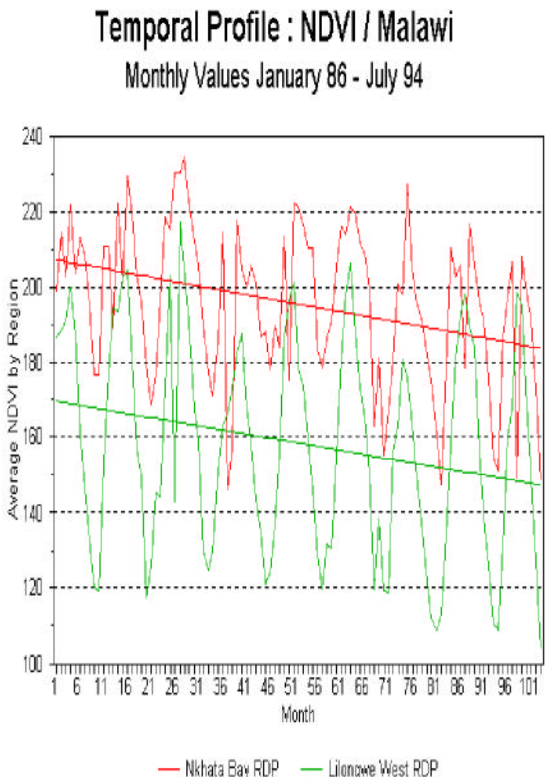


Figure 2 : A pair of temporal profiles developed from 103 consecutive months of NDVI imagery. The technique used for the analysis examines all pixels that fall within each of two Rural Development Projects (RDP's) and calculates their mean for each month. The Intermediate class that conducted this analysis noted that many districts exhibit a decreasing trend in apparent NDVI over the eight year sequence. Analysis of this trend formed part of the follow-up advanced training course.

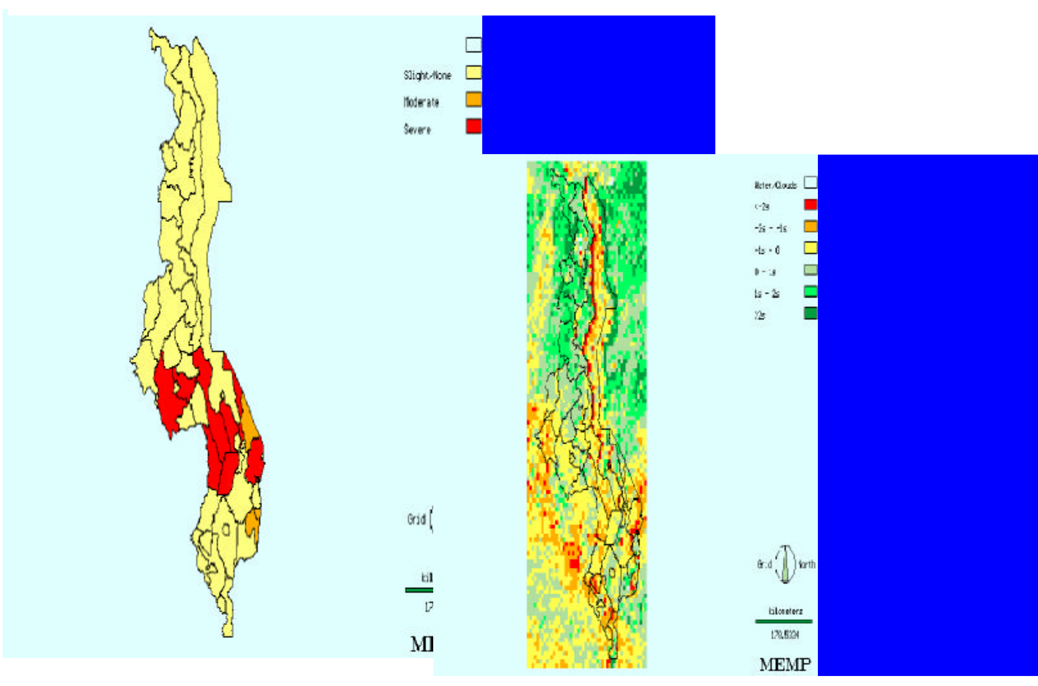
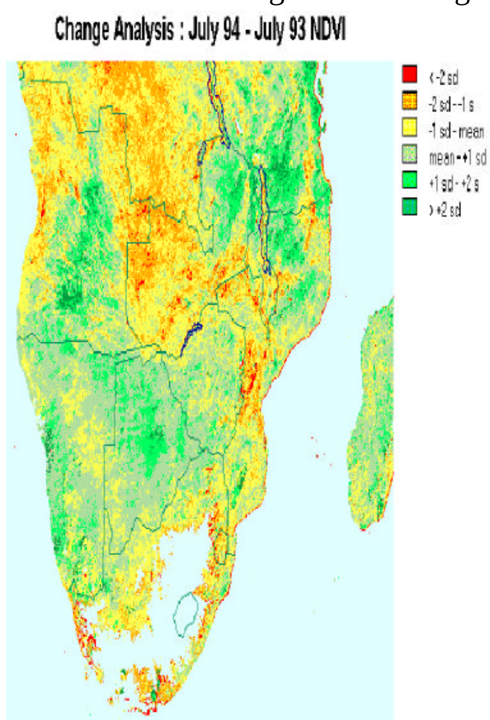


Figure 3 : A map of food security assessments for 1994 that was compared to an analysis of change in vegetation levels by the introductory trainee class. A significant statistical relationship was found.

Appendix III : Drought Monitoring

This application was developed during the training sequence and illustrates the change detection procedures that were learned by the trainees and their application to environmental monitoring. The application used monthly vegetation index (NDVI) data from the Famine Early Warning System (FEWS) program to examine anomalies from January to May 1995. Difference images were processed into Standard Deviation classes (Figure 1). The analysis was able to show a movement in the main drought cell from Namibia/Botwana in January to Zimbabwe to Southern Zambia in May. The same sequence of images were produced for January to May 1987, the last significant El Niño drought (Figure 2). The similarities are dramatic and are characterized by the compilation maps for each year showing monthly maximum anomalies in vegetation over the same months for the two years (Figure 3). Companion images for each composite shows the relative trend surface, or best fit surface, in order to detect the general trend in movement from the southwest to the northeast. It was during the course of the training GIS training and exploration by the trainees that detected the 1995 El Niño drought back in July 1994. Figure 4 shows the precursor image that tipped off this trend and shows the change in mean vegetation between July 1993 and July 1994 with the drought cell forming in Southern Africa. July 1994 was the first month the trainees began their monitoring exercises.



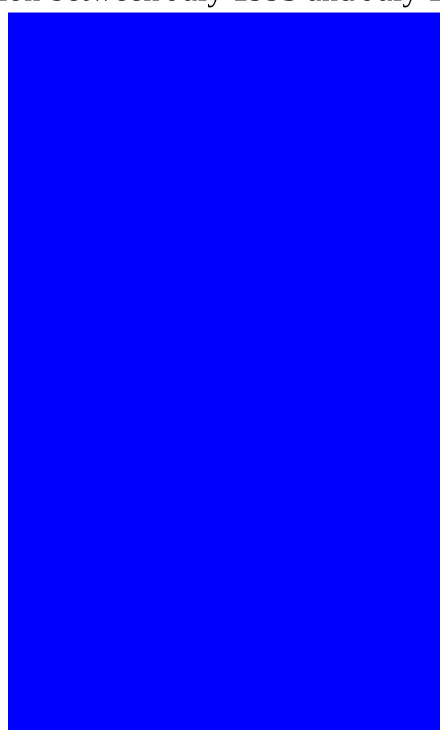


Figure 1 : Drought cell formation precursor image for Southern Africa showing difference in standard deviation units in mean vegetation between July 1993 and July 1994.

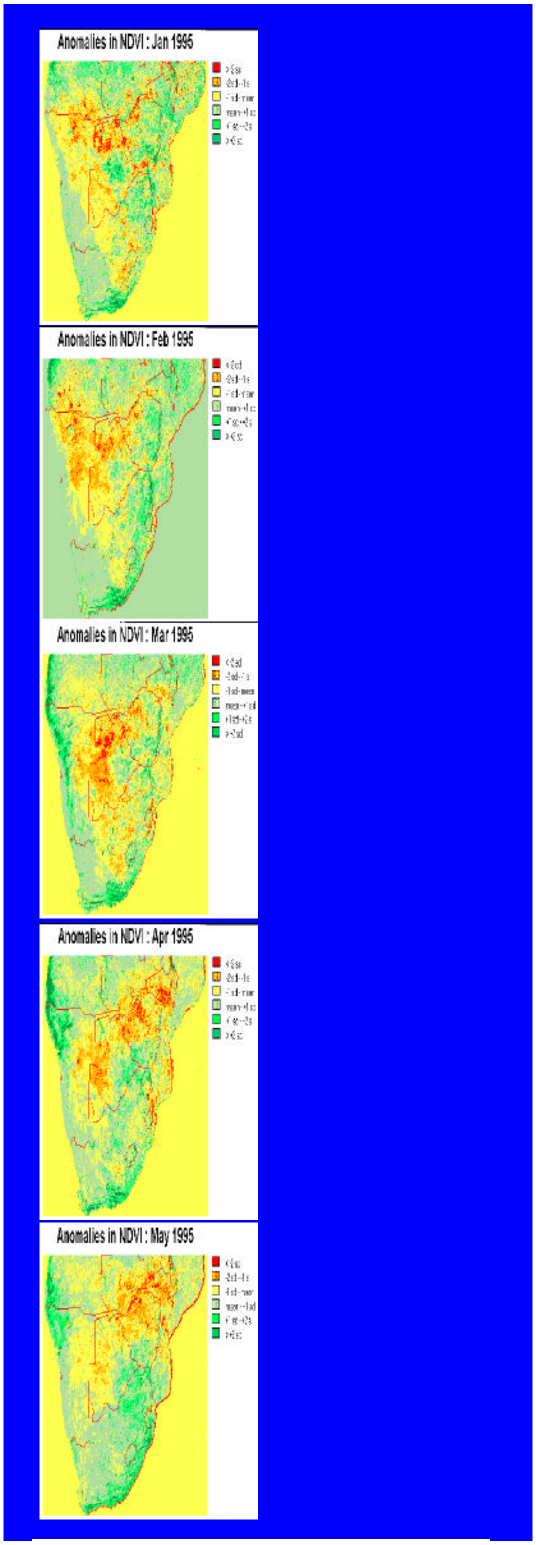


Figure 2 : Anomalies in standard deviation units from seven year normals, 1995.

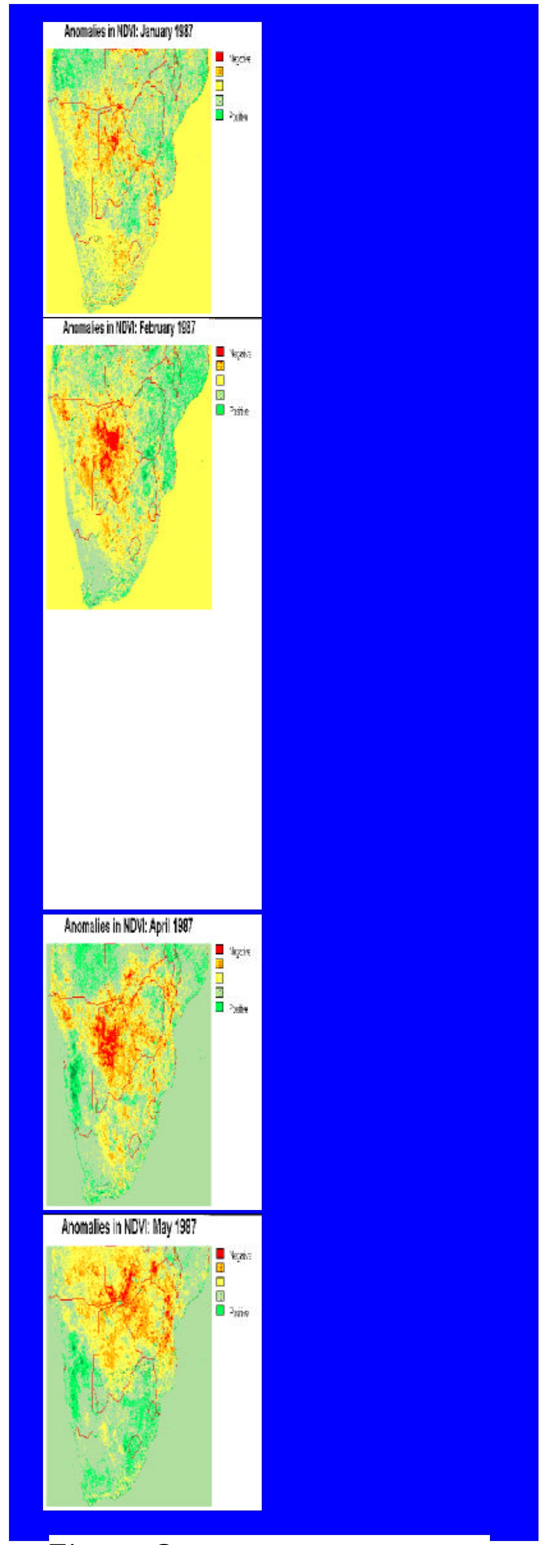
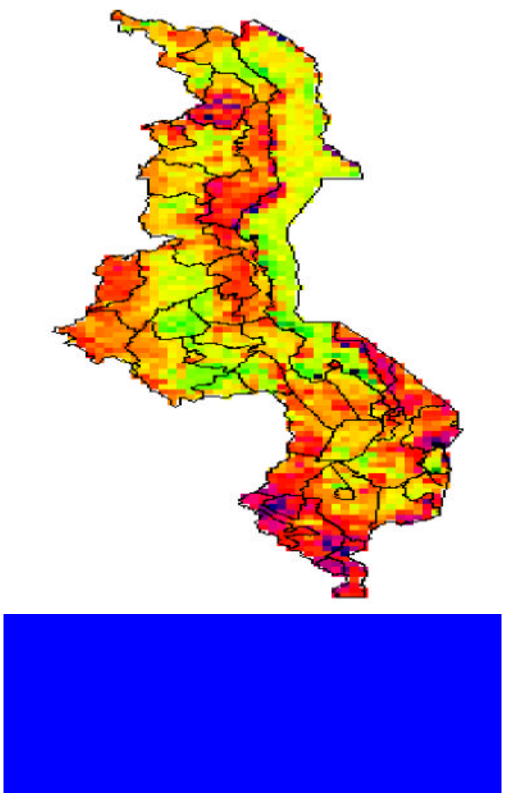


Figure 3 : Anomalies in standard deviation units from seven year normals, 1987.

Principal Component 6



Appendix IV: Forest Change Analysis

This application developed during the trainings illustrates the use of GIS and remote sensing for monitoring natural resources. The study employs a technique known as principle components analysis which seeks to isolate changes in vegetation over many years. In this case study, 84 months of AVHRR satellite imagery data, from 1987 to 1994, were analyzed to detect changes in vegetation using standardized NDVI, normalized difference vegetation index. NDVI is an index derived from reflectance measurements in the red and infrared portions of the electromagnetic spectrum to describe the relative amount of green biomass from one area to the next. Figure 1 shows Component 6 from the analysis which successfully isolated changing negative anomalies in vegetation cover (darker red and blue) related to the changing Malawi Forests over this same seven year period. The two graphs in Figure 2 show the significant decline in vegetation for all protected forests in Malawi and one selected forest reserve, Phirilongwe. To further verify the results of this methodology, larger scale analysis was used that employed Landsat MSS 80 meter and Landsat TM 30 meter. Figure 3 shows false color composite images for the two years 1981 and 1991 for the Phirilongwe Forest Reserve located in Central Malawi. The red in both images show the extent of vigorous growth from the forest cover and its significant decline over the 10 year period until 1991. This application demonstrates the relatively inexpensive and rapid analysis available using GIS and remote sensing technologies using the same small scale NDVI data that is available at MET on a continuos basis.

Figure 1 : Principal Component 6 showing negative vegetation anomalies (darker areas) coinciding with Malawi's protected forests.

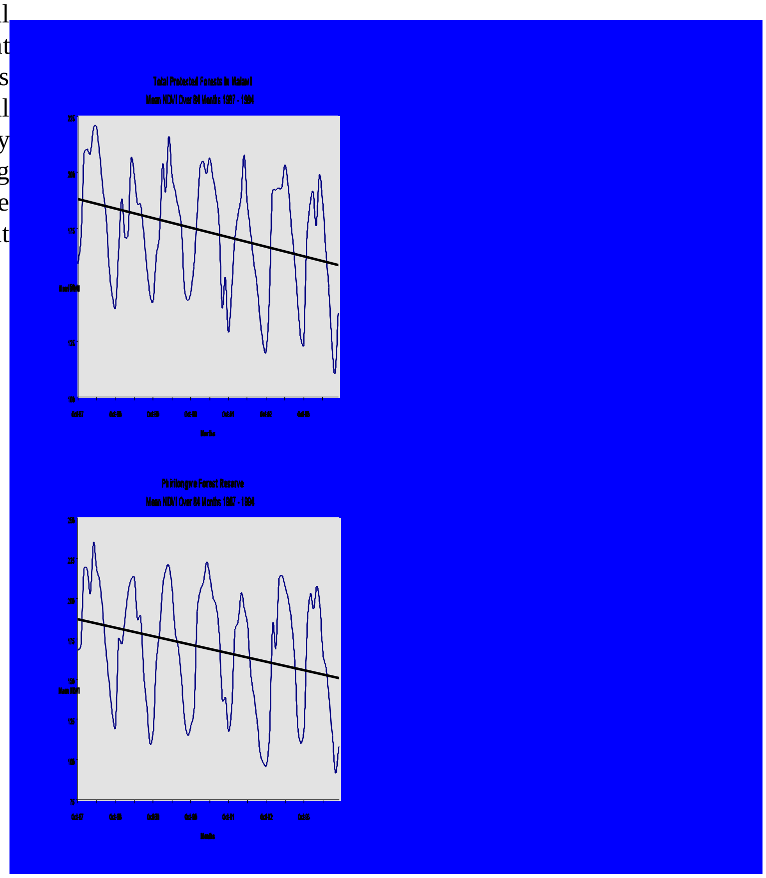


Figure 2 : Two graphs showing decline in vegetation (NDVI) for all protected forests in Malawi and one selected forest reserve, Phirilongwe.

Figure 10 : False color composite images for the two years 1981 and 1991 for the Phirilongwe Forest Reserve located in Central Malawi. The red in both images show the extent of vigorous growth from the forest cover and its significant decline over the 10 year period.